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Time-dependence of bioenergy emission intensities and strategies to reduce pay-back times

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IEA Bioenergy

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Task 38 Expert Meeting

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Outline

- Introduction
- Bioenergy examples
- Sensitivity
- Policy criteria & indicators
- Conclusions

Disclaimer

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Introduction

1. Understand usefulness of emission intensities
   - Simple indicators for policy makers
   - Consumption-based accounting systems
2. Develop strategies to reduce the payback time
3. Understand the risks in estimating impacts of bioenergy systems
   - Will the “carbon-investment” bring “carbon dividends”?
4. Bioenergy type-profiles
   - Use versus decay
   - Use → regrowth
   - Growth → use
   - Annual crop (with iLUC)

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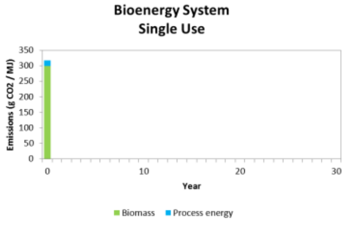
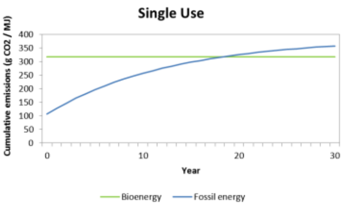
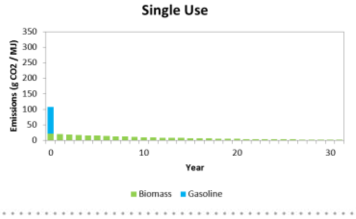
Use versus Decay
Forest residues







- Bioenergy System
  - Biorefinery producing bioethanol and phenols
  - Approx. 30% conversion efficiency
  - Supply-chain emissions = 18 gCO2/MJ
- Reference System
  - Residues decay, average lifetime = 12.9 years
  - Gasoline, process emissions = 85 gCO2/MJ

From Cherubini et al – Task 38 Case Study
In press.

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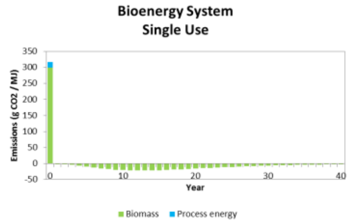
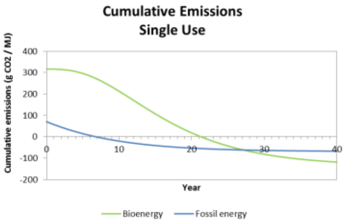
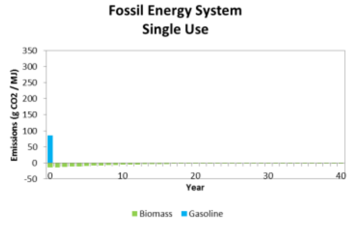
Use → Regrowth
Live biomass (trees) without risk







- Bioenergy System
  - Forest – 20 year rotation
  - Biorefinery producing bioethanol and phenols
  - Approx. 30% conversion efficiency
  - Supply-chain emissions = 18 gCO2/MJ
- Reference System
  - Continued growth of forest
  - Gasoline, process emissions = 85 gCO2/MJ

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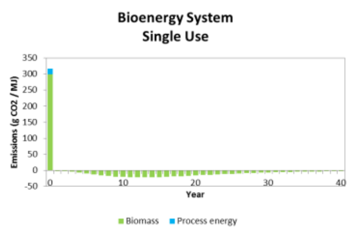
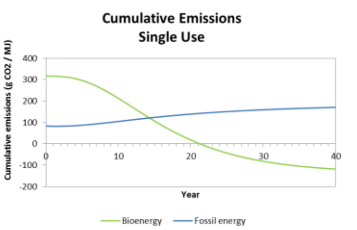
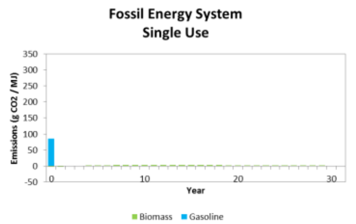
Use → Regrowth
Live biomass (trees) with risk

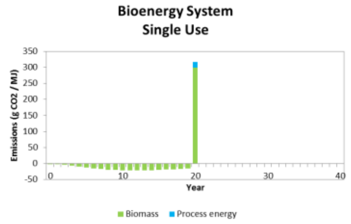


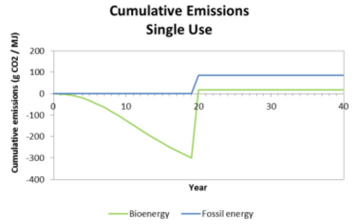


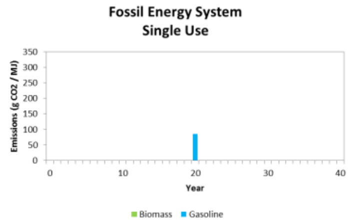


- Bioenergy System
  - Forest – 20 year rotation
  - Biorefinery producing bioethanol and phenols
  - Approx. 30% conversion efficiency
  - Supply-chain emissions = 18 gCO2/MJ
- Reference System
  - Continued growth of forest
  - 2% risk of loss to fire annually (assumed)
  - Gasoline, process emissions = 85 gCO2/MJ

Growth → Use
New plantation







- Bioenergy System
  - New plantion – 20 year rotation
  - Biorefinery producing bioethanol and phenols
  - Approx. 30% conversion efficiency
  - Supply-chain emissions = 18 gCO2/MJ
- Reference System
  - Gasoline, process emissions = 85 gCO2/MJ

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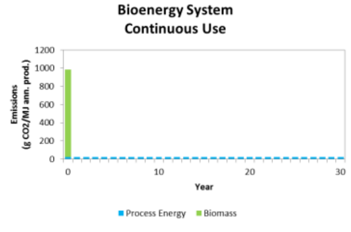
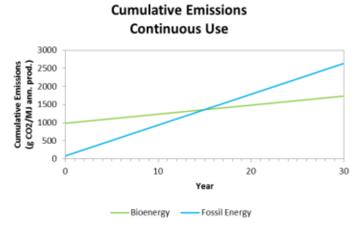
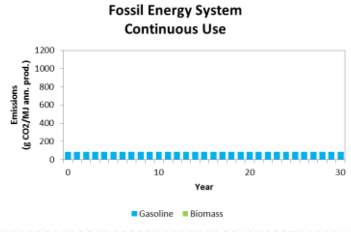
Annual Crop
With landuse change







- Bioenergy System
  - Sugar cane – based ethanol
  - Supply-chain emissions = 25 gCO2/MJ
  - Direct land use change fixed so that payback time is 15 years
- Reference System
  - Gasoline, process emissions = 85 gCO2/MJ

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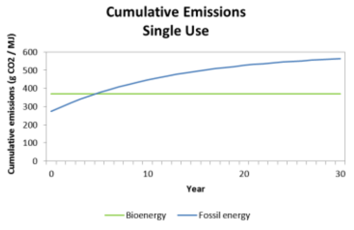
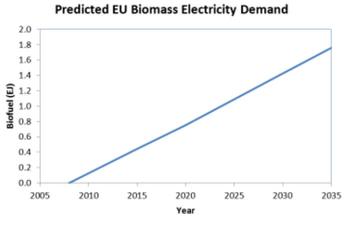
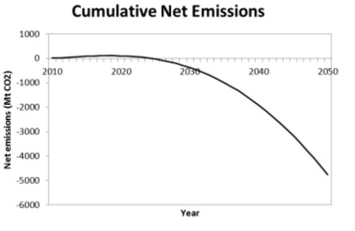
Sensitivity
Technology



- Bioenergy System
  - **Residues to wood chips to CHP**
  - Approx. 27% conversion efficiency
  - Supply-chain emissions = 22 gCO2/MJ
- Reference System
  - Residues decay, average lifetime = 12.9 years
  - Coal burning CHP
  - Conversion efficiency 43.5%
  - Emissions = 248 gCO2/MJ

From GEMIS





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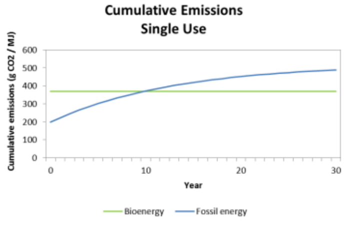
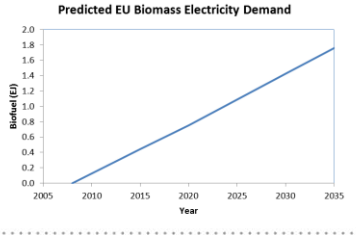
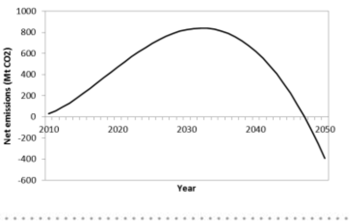
Sensitivity
Fossil energy replaced



- Bioenergy System
  - Residues to wood chips to CHP
  - Approx. 27% conversion efficiency
  - Supply-chain emissions = 22 gCO2/MJ
- Reference System
  - Residues decay, average lifetime = 12.9 years
  - **Natural gas CHP**
  - Conversion efficiency 42.3%
  - Emissions = 173 gCO2/MJ

From GEMIS





Sensitivity
Efficiency

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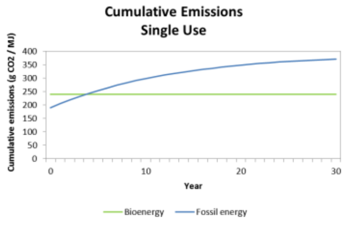
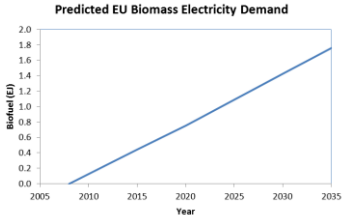
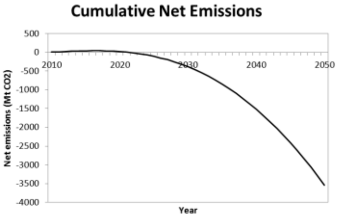


- Bioenergy System
  - Residues to wood chips to CHP
  - **Approx. 42% conversion efficiency**
  - Supply-chain emissions = 22 gCO2/MJ
- Reference System
  - Residues decay, average lifetime = 12.9 years
  - Natural gas CHP
  - Conversion efficiency 42.3%
  - Emissions = 173 gCO2/MJ

From GEMIS





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Policy Criteria & Indicators

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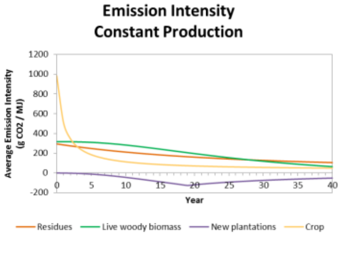
- Current policy provides incentives for bioenergy systems that reach a specific emission intensity
- Emission intensities are time dependent



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Policy Criteria & Indicators

- Policy should provide incentives for bioenergy that meets specific
  1. Conversion emission intensity
  2. Supply-chain emission intensity
  3. Payback time or recovery time

$$T_{payback} = f(I_B, I_S, I_F, T_{return})$$

I_B	Conversion emission intensity
I_S	Supply-chain emission intensity
I_F	Displaced fossil fuel intensity
T_{return}	Recovery time (e.g. decay rate, rotation length)

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Conclusions

- Emission intensities of bioenergy systems are time dependent
- Payback period can be minimised by using bioenergy
  - From purpose grown biomass (e.g. new short rotation forests)
  - To replace appropriate technology
  - To replace carbon intense fossil energy
  - With high efficiency
  - With quick recovery or natural return
- Policy criteria & indicators should consider
  - Conversion emission intensity
  - Supply-chain emission intensity
  - Payback time or rotation length / decay rate
- Risks will be different for different bioenergy type-profiles

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Thank-you for your attention

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SMART FORESTS - Selecting Management Alternatives Responding to Targets. Forest Optimization for Renewable Energy and Sequestration using Time-dependent Strategies (Austrian Klima- und Energiefonds, Klimafonds - Antragsnummer: B068656).
www.smartforests.at

IEA Bioenergy Task 38 – www.ieabioenergy-task38.org

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